Unit A - Reproduction and Human Development (Life Science: Biology)

Chapter 1 - Cell division occurs in both asexual and sexual reproduction

Outcomes

- Observe and describe the significance of cell division processes
- Distinguish between asexual and sexual reproduction in plants and animals, and provide examples of each
- Compare the advantages and disadvantages of asexual and sexual reproduction for individual plants and animals, and for whole populations

1.1 Cell Division

A1. Quick Science # 1 – 8
Cells: The Basic Unit of Life (Review)
Animal – Cell Structures (BLM 5.2 a)

- The entire cell is cover by a cell membrane.
- The cell membrane controls the movement of material into and out of the cell
- The nucleus acts as a control center, directing all of the cells activities.
- Genetic (hereditary) information is separated into threadlike structures called chromosomes.
- Each chromosome contains many different genes. Genes determine the specific characteristics of each individual.
- The cytoplasm is the area of the cell where work is done. Nutrients are absorbed. Transported, and processed within the cytoplasm.
- The cytoplasm contains different organelles. An organelle is a specialized structure inside a cell.

Plant – Cell Structures (BLM 5.2b)

- Plant cells contain all the organelles found in an animal cell plus a few others.
- The cell membrane of a plant cell is surrounded by a cell wall.
- The cell wall is composed of a rigid material called cellulose.
- The cell wall protects and supports the plant. Gases, water, and some minerals can pass through pores in the cell wall.
- Animal and plant cells both contain vacuole but they are much larger in plant cells.
- Plant cells also contain chloroplasts.

Cell Parts and Terminology

Nucleolus (nuke-lee-o-lus) – spherical organelle inside the nucleus which makes proteins and ribosome
Nucleus (nuke-lee-us) – organelle that acts as the brain/control center of the cell
Chromosome (chrome-o-zome) – contains the genetic information for individuals
Mitochondrion (might-o-con-dree-on) – oval shaped organelle which provides the cell with energy
Cell Membrane – the "gateway" of the cell allows materials in and out
Cytoplasm (site-o-plasm) – fluid in the cell where nutrients are absorbed, transported, and processed
Ribosome (Rye-bo-some) – an organelle that assembles proteins for growth and reproduction
Endoplasmic Reticulum (re-tic-u-lum) – an organelle that carries materials throughout the cell
Golgi (goal-gi) **apparatus** – an organelle that processes and packages proteins
Lysosome (lice-so-some) - organelles that contain enzymes that break down larger molecules
Centriole (sen-tree-ol) – a barrel shaped organelle found only in animals essential to cell division
Vacuole (vac-u-ol) – an organelle (larger in plants) that stores water, sugar, minerals, and proteins
Chloroplast (chlor-a-plast) – an organelle specific to plants that contain chlorophyll and conduct photosynthesis
Cell Wall – found only in plants, composed of cellulose used for protection and support

The Importance of Cell Division

Cells come from pre-existing cells through the process of cell division.

Functions of Cell Division

Healing and Tissue Repair

- Every second millions of cells in your body die or are injured. If the remaining cells did not reproduce, your body would gradually shrink and die.

Growth

- A more obvious function of cell division is to increase the number of cells.
- As the number of cells increase so does the size of the organism
- Human growth begins with the division of a single fertilized egg.
- Why do cells divide instead of continuing to grow in size?
    - Nucleus must be able to send message quickly to all parts of the cell
    - Too much cytoplasm will result in an inefficient exchange of materials through the cell
    - If that one cell died it would take too long to produce a new one.

Reproduction of Organisms

- Cell division perpetuates life.
- For example in a unicellular organism (bacteria) each division creates a new organism.

Unanswered Questions

- With all of our knowledge and research many questions remain unanswered by scientists. For example:
    - How do cells know when to divide?
    - What determines the rate of division?
    - How and why is cell division altered?

Cell Division

The Cell Cycle

- Cells alternate between stages (phases) of dividing and not dividing (regular cell function). This sequence of events is called the cell cycle.

Interphase

- ***Phase of Rapid Cell Growth***
- Cell takes in nutrients such as sugars and produces building materials such as proteins.
- These materials are used by the cell for energy, growth, and repair of damaged parts.

Duplication of Chromosomes

- Genetic information must be duplicated before cell division.
- Chromosomes contain all necessary information for cell function including cell division.

Second Phase of Growth.

- Period of Growth and preparation for division

Mitosis and Cytokinesis

Mitosis

- The process that divides a cells genetic material and usually results in two daughter cells
- Despite the differences in organisms most cells divide in similar ways.
- In all cases an initial mother cell divides into two identical daughter cells.

- Cell division involves the division of nuclear materials and the sharing of cytoplasm, which includes the organelles.
- During cell division, the duplicated chromosomes copied during interphase, divide and move to opposite ends of the cell. This process is called mitosis.
- Cell division continues with the separation of the cytoplasm and its contents into equal parts. This process is called cytokinesis.
- Cytokinesis differs in animal and plant cells. In animal cells the cell membrane pinches off while in plant cell cytokinesis a new cell wall forms between the daughter cells.

The Phases of Mitosis

1. **Interphase** – rapid growth
2. **Prophase** – individual chromosomes are now two identical strands. Nuclear membrane begins to dissolve
3. **Metaphase** – double stranded chromosomes line up in the middle of the cell
4. **Anaphase** – each chromosome splits and the halves move to opposite poles of the cell
5. **Telophase** – nuclear membrane forms around the chromosomes. Cytokinesis begins.
6. **Interphase** – rapid growth and duplication of genetic material.

Mitosis is the division of the nucleus and cytokinesis is the division of the cytoplasm

Cancer Cells

- Normal cells cannot divide in isolation they need cell to cell "communication for normal cell division.
- Cancer cells are capable of dividing in isolation
- The human body has many different cells that have unique shapes and specialized functions.
- Cancer Cells do not change shape or specialize. They simply use up energy and resources.

Cancer Cells

- When cell division goes out of control it is called cancer. Cancer cells divide unregulated and uncontrolled more quickly than they should.
- All cancers are caused by mutations in the genes that regulate cell division. Any substance or energy that causes such a mutation is called a carcinogen.
- Cancer can be treated in different ways

Example

chemotherapy
radiation

Read Pages 4 – 15
Learning Checkpoint p. 11 # 1 - 5
1.1 Check and Reflect # 1 – 10 (p. 15)

1.2 Asexual Reproduction

Modern Cell Theory

- All living things are made up of one or more cells
- The cell is the functional unit of life
- All cells come from pre-existing cells

Organisms of all species reproduce.
Reproduction occurs sexually or asexually.

In asexual reproduction a single organism gives rise to offspring with identical genetic information. (Involves only one parent)

- Bacteria and human cells (other than cells in the ovaries and testes)
- An advantage of asexual reproduction is the quick production of many identical offspring but they must have optimal environmental conditions to survive.
- Asexual reproduction is a fundamental part of the agricultural and forestry sectors in SK

Additional Examples:

- **Binary Fission** – organism splits into two equal sized organisms (unicellular i.e. bacteria)
- **Budding** – offspring begins as a small outgrowth eventually breaking off (hydra)
- **Fragmentation** – a new organism begins from a part that breaks off the original organism (star fish)
- **Spore Formation** – organism undergoes cell division to produce many smaller identical cells called spores (penicillium mould)
- **Vegetative Reproduction** – plants produce runners that can develop into identical separate plants (spider plants / strawberries)
- In sexual reproduction genetic information from two cells is combined to produce a new organism.
- Sexual reproduction occurs when two specialized sex cells unite to form a fertilized egg called a zygote.
- It is possible for organisms to reproduce sexually and asexually.

Read Pages 18 – 23
1.2 Check and Reflect # 1 – 12 (p. 23)

1.3 Sexual Reproduction

Meiosis - cell division that creates sex cells (gametes)

- Sexual reproduction in animals is achieved by the union of male and female gametes
- Organisms that reproduce sexually show a greater range in their characteristics than those that reproduce asexually.
- Homologous chromosomes carry genes that code for the same trait, in the same position on the chromosome.
- Your appearance is determined by the interaction of these chromosomes.

Stages of Meiosis

- Organisms that reproduce sexually contain two types of cells.
- Cells that reproduce by normal cell division and mitosis are called somatic cells.
- Each mother cell separates into two identical daughter cells each with 46 identical chromosomes.
- Reproductive cells produce sex cells that contain only half of the number of chromosomes through the process of meiosis.
- Sexual reproduction requires a large amount of energy to produce a small number of offspring
- Meiosis involves two cell divisions that produce four haploid cells.
- During the first division meiosis I a diploid cell (2n) becomes two haploid cells (n)
- Prophase I - homologous chromosomes pair up and exchange segments
- This crossover accounts for variability among offspring.
- Metaphase I – chromosomes align on the central plane
- Anaphase I – split and move to opposite poles (23 chromosomes each)
- Telophase I – Cytokinesis results in two haploid cells (23 chromosomes each)
- In the second phase, meiosis II, the chromosomes are divided in the same manner but no DNA replication is involved.
- One parent cell produces four daughter cells. Daughter cells have half the number of chromosomes found in the original parent cell and with crossing over, are genetically different.

Mitosis (cell growth/healing/reproduction) vs. Meiosis (sexual reproduction)

- Chromosome behaviour
  - Mitosis: Homologous chromosomes independent
  - Meiosis: Homologous chromosomes pair forming crossover chromosomes.
- Chromosome number- reduction in meiosis
  - Mitosis- identical daughter diploid cells (46 chromosomes)
    - One cell division
  - Meiosis- daughter cells haploid (23 chromosomes)
    - Two cell divisions
- Genetic identity:
  - Mitosis: identical daughter cells
  - Meiosis: daughter cells have new assortment of parental chromosomes

Read Pages 27 – 34
Learning Checkpoint #1 – 4 (p. 30)
Learning Checkpoint #1 – 3 (p. 32)
1.3 Check and Reflect # 1 – 12 (p. 34)
Chapter 1 Review # 1 – 30 (p. 38 – 39)

Chapter 2 - Genetic information is passed from parents to offspring

Outcomes

- Examine ways that genetic information is transferred and the factors that may influence the process
- Examine the impact of genetics on society past and present

2.1 Variation and Characteristics

A8 – Variations in Characteristics within our Class

- Heritable traits are the characteristics of an organism that are inherited from the organisms parents
- Variation can be discrete (either/or)
- Variation can be continuous (range of forms)
- Variation can be affected by heredity and the environment
- Not-heritable traits are traits that are learned or developed during a lifetime
- The First Nations and Métis way of understanding heredity include transmission of both personality and physical traits

Read Pages 41 – 45
2.1 Check and Reflect # 1 – 7 (p. 45)

2.2 Heredity and Genetics

- The nucleus of the cell contains DNA which has the genetic information that is required for cells to divide and is responsible for heredity
- All chromosomes contain the same genetic chemical called deoxyribonucleic acid (DNA)
- DNA provides the direction on how cells will change to certain environments and to messages from other cells.
- Genes are segments of DNA that contain instructions for characteristics. Alleles are a variation of genes that provides info for a trait.

The Code Inside the Chromosome

- DNA has an interesting structure made up of a series of chemicals called nitrogen bases held in a long winding helix.
- DNA uses a four-character code made up of the nitrogen bases.

A – adenine (add-neen)
T – thymine (thigh-meen)
C – cytosine (site-o-seen)
G – guanine (gwa-neen)

- The order that these bases appear in is the code.
- The genetic code is arranged in "words" two nitrogen bases and those words connect to form "stories" which are the genes.
- The "language of life" the genetic code is stored in 6 billion nitrogen bases of DNA arranged in about 100 000 genes on the 46 human chromosomes.
- Traits can be dominant or recessive, and the combination of alleles from the parents determines which traits the offspring will display

Read Pages 47 – 54
2.2 Check and Reflect # 1 – 11 (p. 54)
A17 Exploring Genetic Possibilities

2.3 Genetics, Technology, Society, and the Environment

- Genetic conditions are passed on from parent to offspring
- Some personal choices and environmental factors can alter a cell's DNA
- Developments in the study of genetics have a major impact on society
- Saskatchewan plays a major role in the study of genetics

Biotechnology

- Food and crop production, population size, the spread of disease, and the environment are all affected by the study of genetics

Examples

Selective Breeding
Artificial Reproduction Technology
artificial insemination
in vitro fertilization
Genetic Engineering

Accidental Changes to DNA

- DNA is sometimes inadvertently altered or damaged by environmental factors and personal choices

Examples

Carcinogens
Sun Exposure

DNA, Mutations, and Cancer

- DNA maybe exposed to radiation, chemicals or viruses this may change the sequence of nitrogen bases.
- Changes in the genetic code are called mutations.

Mutations
Mutations Explained

Genetic Conditions

A genetic condition is a disease or disorder caused by damaged or faulty DNA

Examples

Male infertility
Breast Cancer

Sex-linked Genetic Conditions

- Chromosomes always come in pairs
- In humans they are X and Y chromosomes
- Females are XX and Males are XY
- Females can only pass on an X
- Males can pass either a X or a Y

Examples

Colour Blindness and Haemophilia

- Males are more likely to inherit sex-linked genetic disorders because they receive only one X chromosome.

Read Pages 58 – 70
2.3 Check and Reflect # 1 – 10 (p. 70)
Chapter 2 Review # 1 – 24 (p. 74 – 75)

Chapter 3 – The process of human reproduction can be affected by technology

Outcomes

- Examine the process and influences on the transfer of genetic information and the impact of that understanding on society past and present
- Analyze the process of human reproduction, including the influence of reproductive and contraceptive technology

3.1 Reproduction and Puberty

- Humans are usually born with the necessary reproductive organs but are not yet able to reproduce
- Puberty is
  - The process of development and growth of the adult form and sexual maturation
  - when males and females begin to produce mature gametes
- First Nations and Métis cultures view puberty as a transitition from childhood to adolescence which involves
  - Physical
  - Emotional
  - Mental
  - And spiritual aspects

Read Pages 77 – 80
3.1 Check and Reflect # 1 – 8 (p. 80)

3.2 <u>The Male Reproductive System (MRS)</u>

- The MRS produces gametes and are regulated by hormones
- Testosterone is an important hormone in the function of the MRS
- Each structure in the MRS has an important function
- The production of sperm is a continuous process

Read Pages 81 – 84 + Line Master A10
3.2 Check and Reflect # 1 – 8 (p. 84)
#6 uses Line Master A10

3.3 <u>The Female Reproductive System (FRS)</u>

- The FRS produces gametes and are regulated by hormones
- The main functions of the FRS is to produce eggs and to provide a safe place for fertilization and development
- Estrogen is an important hormone in the function of the FRS
- Each structure in the FRS has an important function
- The release of eggs occurs in a cycle
- Read Pages 85 – 90 + Line Master A11

3.3 Check and Reflect # 1 – 12 (p. 90)
#11 (use Line Master A11)
Quick Science A27 – How Many Eggs?

3.4 Human Development

- Fertilization occurs when the nucleus of an ovum fuses with the nucleus of a sperm
- Females show physical signs of pregnancy once an egg has been fertilized
- It takes approximately nine months (40 weeks) for a human to develop from conception to birth

Read Pages 93 – 99
3.4 Check and Reflect # 1 – 9 (p. 99)

3.5 <u>Contraceptive and Reproductive Technology</u>

- There are many methods of contraception that prevent pregnancy from occurring

Example
condoms
oral contraceptive pill
contraceptive injections
intrauterine device
sterilization
Infertility can sometimes be treated using science and technology advances

Example
artificial insemination
in vitro fertilization
In various different ways, society affects how science and technology proceed
Scientific and technological advances can be controversial because of the different social and cultural beliefs that exist in society

Read Pages 101 – 107
3.5 Check and Reflect # 1 – 8 (p. 107)
Chapter 3 Review # 1 – 32 (pg. 110 – 111)
Unit A Review #1 – 57 (p. 115 – 117)